Designers in White Coats: Deploying Ovum, a Fertility Tracking Device

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ABSTRACT
As self-tracking practices continue to proliferate, there has been a call for a consideration of how the design of these devices influence the users experience of themselves and their bodies beyond utility, efficacy and accuracy. The research product Ovum was designed to facilitate a DIY, shared, domestic experience, rather than an expert-led, individual, clinical experience of fertility tracking. Ovum uses the method of saliva sampling to determine ovulation. This paper unpacks the findings from a three-month long deployment of Ovum with seven couples trying to conceive. Besides an evaluation of the device in terms of the three experiential qualities aimed for in the design process, we report on the consequences of executing a design deployment that resembles a clinical trial. We contribute our experience in order to develop an understanding of how designing for the body places interaction designers in novel and complex situations.

Author Keywords
Self-Tracking; Ovulation; Women's Health; Research through Design; Menstrual Cycles; Fertility;

CSS Concepts
• Human-centered computing~Interaction design~Interaction design process and methods

INTRODUCTION
With a proliferation of self-tracking practices, there has been a call for a consideration in terms of how the design of these devices influence users' experience of themselves and their bodies beyond utility, efficacy and accuracy [30, 41, 45]. HCI researchers can support the trial of medical devices to understand core everyday use issues and improve their design [37]. Interaction design, and particularly research through design, has been increasingly employed within HCI to offer alternative designs of devices that track and interact with the insides of the body. These include critical and speculative imaginings of new futures of self-tracking devices [19, 27, 49]; to explore alternative visualizations of physiological data beyond the screen [17, 25, 31]; to design an inclusive experience of tracking ambiguous and enigmatic diseases [4, 5, 35]; and to allow users to design their own self-tracking systems in order to make sense of their own data [1].

Fertility tracking has been a topic increasingly present within the field of self-tracking within HCI [9, 12, 22, 28, 48]. Fertility tracking is used to determine when the egg is released from the ovaries and can be done with the aim of conception or contraception. The two most common methods for fertility tracking are: urine testing for a rise in the luteinizing hormone that occurs 24-36 hours before ovulation, and temperature tracking which algorithmic methods to predict fertility using the sharp rise in basal body temperature after ovulation. If the user has a regular menstrual cycle, they can use this rise in temperature to predict the date of the next ovulation. The laborious nature of having to track temperature daily has resulted in the design and marketing of a range of wearable Bluetooth connected thermometers that automatically sync their data with apps such [3, 53]. Digital and connected urine testing devices such as [10, 13] are marketed to negate ambiguity in reading the results of paper urine testing sticks. These devices show a smiley face on a small digital screen integrated within the device when the results show that the user is fertile.

We previously designed Ovum, a fertility tracking device designed to aid conception, rather than to be used for contraception. More information about this process has been reported in a previous publication [21]. Fertility tracking has been shown to be a complex, emotional and highly personalized act [12]. Rather than only designing for utility, efficacy and accuracy, we want to understand how the ways that self-tracking devices are designed shape users' experience of this complex act. We wanted to understand what would result from using oppositional qualities in the design of self-tracking devices. We expanded the design space around self-tracking through challenging current designs of self-tracking devices. Ovum is the result of a research through design process where we attempted to design for fertility tracking as a DIY, shared, domestic experience, rather than an expert-led, individual, clinical experience. This paper reports on the next stage of this research project; the results of a three-month long deployment of the research product, Ovum, with 7 couples attempting to conceive. We first present the design and why

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and how it uses the fertility tracking method of saliva tracking. We then present our findings in terms of how the experiential qualities we intended towards in the design process translated into the lived experience of our participants. Our discussion reflects on our findings and how the results produced by Ovum throughout the study produced a situation where our participants understood the study as a clinical trial rather than a design deployment; despite our efforts, our participants saw us as designers in white coats. We contribute our experience in order to develop understanding of how designing for the body places interaction designers in novel and complex roles and situations.

OVUM

We will now briefly present the research product Ovum and the method of saliva tracking in order to provide background to the study.

Saliva Tracking

Ovum uses saliva tracking as the method for testing for ovulation. Saliva tracking is ideally done first thing in the morning or at least two hours after eating or brushing teeth in order to avoid contamination of the saliva sample. A drop of saliva is placed on a glass plate and left to dry for at least 10 minutes. Levels of estrogen and adrenocorticotropic hormone increase before ovulation and this stimulates the release of aldosterone. This hormone increases the salt levels in saliva. It is this crystallization of the increased levels of salts in the body fluids that cause ferning pattern visible under a microscope (Figure 1.) [2]. There ferning crystals appear 3-5 days before ovulation (Figure 1b.) and increase as ovulation occurs (Figure 1c.) before disappearing 1-2 days after (Figure 1a.).

Figure 1. Saliva samples during the menstrual cycle. 1a shows before and after the fertile period, 1b display approaching ovulation and 1c shows ovulation.

The history of saliva tracking can be traced back to 1969 when salt crystallization in 1000 women was found to correlate with the fertile period of the menstrual cycle [15, 51]. Salivatory tracking has been found to ascertain a woman's fertile period with a success rate from 86.5% [44] to 90% [15]. However, [7] found this method to be inaccurate; ferning patterns were found in saliva samples of two women during unfertile phases of their cycles, and in samples taken from men, pregnant women, and babies. On the U.S. Food and Drug Administration (FDA) site for saliva tracking, it is stated that *"This test may not work well for you. Some of the reasons are; not all women fern; you may not be able to see the fern; women who fern on some days of their fertile period, don't necessarily fern on all of their fertile days"* [43]. Despite this, commercial saliva tracking devices such as Ovatel report that they have FDA approval "with 98% accuracy" [42].

Saliva tracking previously took place in a doctor's surgery with medical grade microscopes, before mini-microscopes such as [14, 34, 42] began being marketed for at-home use in the late 1980s [11]. These mini-microscopes have been found to be equally effective as clinical apparatus in gauging the presence of ferning crystals [51]. Mini-microscopes are lipstick sized devices that include a small lens with a glass plate beneath it and a focusing ring to manipulate and focus the lens. At the bottom of the tube is an LED light. The lens is lifted out of the device, a drop of saliva is placed on the glass plate and replaced. After the saliva sample has dried it can be inspected through peering into the lens and turning on the LED. This allows the sample to be inspected for crystallization.

Salivatory tracking is recommended for fertility tracking with the aim of conception, rather than contraception. This is because sperm can survive up to 7 days inside the vagina after being ejaculated. Ferning begins to occur 3-5 days before ovulation. Therefore, even if the last instance of sexual intercourse took place before the ferning crystals appeared, sperm might still be alive and able to fertilize the egg as it is released from the ovaries.

The method of tracking ovulation through saliva has recently entered into the HCI domain due to the possibility of integrating artificial intelligence into the process of reading the saliva sample e.g. [26, 56]. Cameras and image processing methods can be used to recognize the density of salt crystals present in the saliva sample. This is used to predict in how many days ovulation will occur.

Designing for a D.I.Y., Shared and Domestic Experience

As reported in [21], our aim was to open up and expand the design space around fertility tracking through designing for more than utility, efficacy and accuracy. Our research group comprised of two interaction designers and one industrial designer and our study was guided by and adhered to our university's research standards. We will now present our design decisions that resulted in the Ovum device.

D.I.Y.

As mentioned, the most common methods for determining fertility are urine testing and basal body temperature tracking. Despite the fact that these devices are marketed for their apparent clarity of results, it appears that ambiguity is a common factor in fertility tracking, across all the different methods [54]. For example, although urine testing devices are advertised as having a 99% accuracy rate [13], users of urine tracking methods use forums to post photos of their testing strips in order to crowd source opinions about what they display. [48] directly designed for uncertainty within temperature tracking of ovulation through showing percentages of certainty with the predictions of ovulation.

This was in order to investigate the implications of avoiding an unrealistically accurate depiction of the menstrual cycle.

We felt that the method of salivatory tracking accounts for ambiguity in fertility tracking through allowing the user to draw their own conclusions from the data. Rather than presenting the body as fitting into distinct diagnoses of "fertile" or "not fertile", saliva tracking allows for a more flexible and idiosyncratic depiction of fertility over the menstrual cycle. We therefore chose it as the ovulation tracking method we would design around. Our intention was to use interaction design methods to re-design existing mini-microscopes used for saliva tracking. The saliva tracking method that we would employ is precisely the same as used by mini-microscopes. i.e. using a 60X magnifying lens to inspect saliva samples.

Saliva tracking demands that the user analyze their own sample for ferning crystals in order to draw their own conclusions as to their fertile state. The results are not mediated by the device. This is with the exception of the saliva tracking devices mentioned previously that include cameras and image processing to computationally evaluate the saliva sample and transmit the results to the user. Salivatory tracking places the user in a different role and relationship to their data - they gain agency and expertise in reading their own fertile state.

Figure 2. Ovum projecting the saliva sample onto the ceiling.

Shared

In designing for more than utility, efficacy and accuracy, we considered the social context that the device would be used within. Though it is possible for individuals to conceive alone through insemination, it is typically a process that involves two people and we design specifically for these cases. Rather than peering into a microscope, Ovum was designed to project a 60X magnified silhouette of the saliva sample out into the room. The user removes the top disc of the device, places their saliva sample on a small glass plate, waits for it to dry then replaces the disc and turns it into place to turn on the LED. The light from the LED then shines back through the lens a projects a silhouette of the saliva sample to a size of 2 meters onto the ceiling or wall.

Making the sample large and present in the room for more than one person to appraise was a decision based on our desire to trouble the fact that ovulation testing devices were found to be marketed solely to the partner who would be carrying the baby [54]. This risks reinforcing societal expectations that, from the very moment of conception, the burden of care of the child is the responsibility of the partner that will become pregnant [33]. We aimed to propose a shared act of fertility tracking, which would share the experience of childcare, right from the very first instance of the planning and preparation for conception.

Domestic

We found the design of fertility tracking devices to replicate either medical devices, or in the case of mini-microscopes, lipsticks in order to disguise the fact they are related to fertility tracking. Our design process was focused on understanding what factors play into the experience of self-tracking and how these factors could better be reflected in the design of the self-tracking devices. Since ovulation tracking is typically done in the home, the design of Ovum draws from homeware objects such as vases and ornaments in its form and materiality. We commissioned a ceramicist to create a ceramic base for the device that gives it a heavier weight than other fertility tracking devices. The rounded base invites for an intimate interaction with the device as it demands to be held in order to keep the projection steady (Figure 3.).

Figure 3. Ovum being turned on by rotating the top disc.

DEPLOYING OVUM

Ovum was deployed for three-months with 7 couples trying to conceive. The aim of our study was to understand how the oppositional experiential qualities that Ovum was designed with would translate into the lived experience of users. We did not carry out our design process with the expectation that our design intentions would translate accurately into actual use. Though designers are aware of their inability to design or dictate how objects are used and what experience they provide, it is an essential part of the design process to follow some imagined notion of a user in a certain context having a certain experience [46]. Hallnäs and Redström propose that designers consider how objects are "present" in the lives of users through designing with an awareness that objects are

the bearer of certain expressions [18]. We believed that putting Ovum to actual use through long-term deployments might help us gain an understanding of the implications of our use of oppositional experiential qualities within the design of fertility tracking devices.

We designed packaging for the device that resembled a commercial device in quality and durability (Figure 4.). The instructional pamphlet that accompanied the device was also designed so that Ovum could be used out-of-the-box, without an onboarding process, though we did go through the instructions with participants during the initial interview (Figure 5). Producing a research product with a high level of finish, rather than a lo-fi speculative prototype, was driven by a desire to allow our participants to reflect on how Ovum compares with other commercial examples [21, 39].

Figure 4. An unboxing of Ovum.

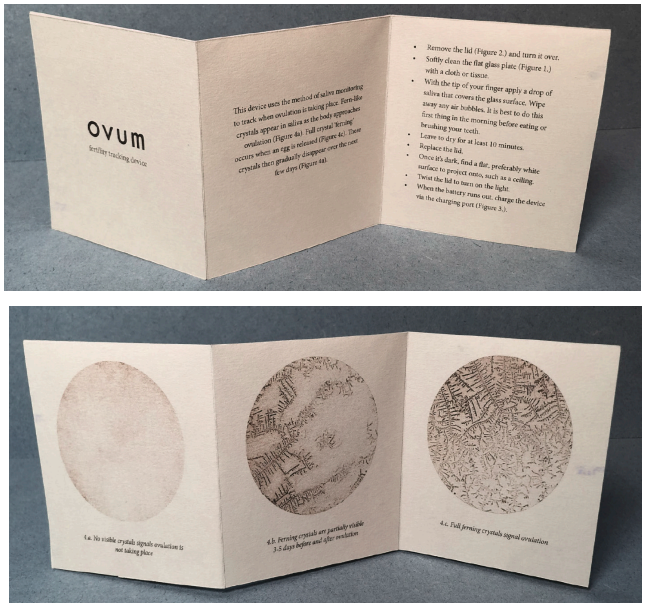

Figure 5. The pamphlet accompanying Ovum giving a short explanation and instructions for use.

Recruiting Participants

We used posts on social media sites to recruit participants. Our criteria for participants was that they were a couple who were attempting to conceive. Prospective participants were given a questionnaire to fill in their ages, how long they had been attempting to conceive, what fertility tracking methods they had used, and why they wanted to participate in the study. We then used this information to select 9 couples from the 22 questionnaires we received to participate in the full study.

Participants were selected based on the fact that they had not been attempting to conceive for more than 10 months. This was to avoid cases where fertility might be an issue warranting further medical intervention, or where fertility might be very emotional due to them having experienced long periods of failing to conceive. All participants were living in Sweden. All were cis-gendered, heterosexual couples, though we did not choose participants based upon these criteria. Ages of participants ranged from 23 to 43.

Ethical Considerations: Getting Informed Consent

A number of steps were taken in order to ensure that we obtained informed consent from our participants. All participants were explicitly informed that they would be part of an interaction design study, rather than a clinical trial on the method of saliva tracking. None of the participants had previously heard of or used the method of saliva tracking. An information sheet about the method of saliva tracking was provided before the study began that referenced medical science articles outlining previous studies investigating the efficacy of the method, e.g. [7, 43, 44, 47]. Participants were also informed that this is a method that has been shown to be ineffective for a percentage of bodies and that is was not 100% accurate at predicting fertility. It was clearly stated to participants that being part of this study would not guarantee conception. All participants understood that they could leave the study at any time. All participants were able to continue with existing fertility tracking practices throughout the study.

Drop-Outs and Pregnancies

Out of the 9 couples we selected from the questionnaires, two left the study just before it began due to pregnancy. Out of the seven couples remaining, three dropped out within one month of the deployment beginning; one due to pregnancy (P7), one due to the fact that *"(trying to conceive) has been very emotionally punishing in the last months"* (P5), and one because of an unexplained *"change in circumstances"* (P3). Emails asking for follow up interviews were unanswered by all participants. Earlier email correspondences and data from the initial interview with these three couples will be included in this paper.

Research Design

Interviews took place via video call or telephone. 25-60 minute-long, semi-structured interviews took place with each couple at three different intervals; firstly, when participants had initially received the device in the post, secondly, at the end of the first month, and finally, at the end of the third month. An email correspondence took place throughout the study between the first author and participants in order to arrange interviews and to answer any additional concerns or questions. Both members of the couple were present at every interview, though correspondences were always between the first author and the female member of the couple.

We used thematic analysis to categorize and draw findings from our raw data. Analysis of the data was an ongoing process. Interviews were transcribed directly after they took place throughout the study and were used to inform the questions asked in the following sessions. For example, following up on statements and probing themes surfaced in the previous interviews. The following themes developed over the study and were used in a final coding of all raw data. Thematic analysis is a method widely used within design research within HCI, e.g. [35, 40, 48]. Thematic analysis can both draw out the details of the phenomenological experience of participants from an essentialist perspective, but also allows the researcher to surface why the participant says what they are saying from a constructivist approach; *"thematic analysis can be a method which works both to reflect reality, and to unpick or unravel the surface of "reality""* [8; 9]. We wanted to understand the details of our participant's lived experience of Ovum in terms of how the experiential qualities had translated into actual experience, but also uncover wider implications and influencing factors on their experience, including cultural and societal factors.

FINDINGS

As outlined above, we analyzed the results of the deployment of Ovum in terms of the themes arising over the interviews and the three experiential qualities aimed for in the design of Ovum. Through our qualitative research, we understood that there were a number of mismatches between the qualities that we were designing for, and how Ovum actually became part of our participants' lifeworld. These mismatches not only highlight our assumptions as designers, but also how fertility tracking is actually carried out and aspects of fertility tracking that are shaped by other external factors, beyond the scope of the design of the device. PX refers to the participant couples. "A" refers to the female member of the couple and "B" refers to the male member of the couple.

Domestic

The ceramic and rounded design of Ovum proposes different designs for fertility tracking devices beyond clinical aesthetics, pure functionality and hard plastics. Ovum's aesthetics were discussed in our interviews from a few different perspectives.

Initial Reactions

Initial reactions to the device upon its arrival included; *"It feels Scandinavian. It's a clean and nice. I like it."* (P2A), *"it's also nice to have on your nightstand without it not looking good, it looks like a decoration piece"* (P2A), *"But I love the design… It's just very cute. It's like a home decoration piece in a way. It also looks like it's something that I want to keep because it looks so nice"* (P6A). The fact that Ovum was designed to resemble homeware rather than a clinical device resulted in the device being camouflaged in the home; *"it's very discreet. I don't think anyone would know what it was."* (P4A).

A Soft Science Project

P6 had a turbulent journey in terms of their experience of the design of Ovum. During the second interview, one month after using the device P6A told us; *"It also looks like it's, I don't know how to explain but it's like it's a science project thing. It's like it can do this amazing thing blowing up stuff in the ceiling, but it still looks very chic … In Swedish we have this saying, it's like "mjuka värden". It's like soft values… it's more like a soft science project in a way. I don't know how to explain it. It's a softer way of doing it, and how it looks adds on to that feeling"*.

However, when asked to further elaborate on what about Ovum offered these "soft values", P6A altered her opinion; *"I think maybe it's because I am doing the other tracking thing as well. If I was just doing this it would be much more pressure on that, on this device like this is the device to give me the answer"*. P6A later commented; *"Maybe this, the design of it wears off after a while. I'm still pretty new to it. I still think it's like super cute. If I've been tracking it for like half a year maybe I would see it differently because then it would be more like something I have to do"*. P6A then went on to describe critically how this method required more effort than temperature tracking.

Two months later, during the final interview, we asked P6A for her final opinions about the "soft values" that Ovum offered; *"Yeah I actually changed my opinion. Because what I liked about it was like yeah how it looked. Now I think it's a bit more clumsy. Because I don't really know how to store it… Yeah and it's also too heavy. What I first like enjoyed about it was that it was like a sculpture. Now it's more like "OK. This is not so handy." And if I want to travel this is like too much to bring with me. Also, because I looked at other devices since we talked and see like more smaller things that looks a bit easier to get around… Now that I have had it for a while. So, the first, yeah, honeymoon phase is over. Now I just want it to be like what it is supposed to be."* (P6A).

Shared

We designed Ovum with the aim of facilitating shared experiences between our participants. This was through projecting the saliva sample out into the room. Participants were not directed to use the device together, but we did ask about their distinct roles in fertility tracking during the interviews.

Collaborative Acts

From our findings, we can see that a number of factors led to fertility tracking being a collaborative act. These factors included the fact that the emails and interviews included both members of the couple (P1). The fact that the saliva sample was projected appeared to facilitate a shared experience for some participants as they wanted to share the *"cool"* (P4A), or *"beautiful"* (P6A) image of the projected saliva sample when crystals were visible. A key factor that led to a shared experience was the fact that Ovum gave ambiguous results. The primary user would ask their partner in order to gain a

second opinion on whether crystals were visible or not (P1, P2, P4, P6).

P1 were the participants with the most active collaborative involvement. For example, P1B set a calendar reminder each morning to remind P1A to use Ovum, and during the first cycle was often the first one to look at the projection since P1A would take a saliva sample and then leave for work. Collaborative acts were less present for P2, P4 and P6, though all described both looking at the projection at one time or another over the study. For P1B, collaborating in the tracking process represented support in terms of their relationship; *"From my perspective the only thing I can do to be supportive is just to be that coach, like remind, you know… I think some- sometimes I feel like, when she's going on with all this stuff. There's not so much I can do. But I have a little part. I have a little part and that little part is important."* (P1B).

For P1A, participating in the study resulted in broader reflections on gender roles in fertility tracking; *"if I would rewind history I would do it earlier, I would take this conversation about how can we both be a part of this earlier. Like this is our journey together. I just thought that it was my responsibility. But it isn't! To check it out and to have control over it and it's my cycle and I have to know. But I don't have to, we, we can do it together."* (P1A).

Uncollaborative Acts

A range of causes behind a lack of collaboration arose through the interviews. The most common reason for uncollaborative tracking was conflicting schedules (P1, P2, P4, P6). The male partners would either wake up before or after the female partners and this would mean that they were not present for the tracking process.

P1A felt there was limit to P1B's involvement because it was her body that was the focus of the tracking. This perspective was also voiced by P2A; *"It's usually the women that needs to handle a lot of the things in their bodies. I'm just carrying everything as we're working a lot with my body. I think that it's like imbalance in my body or it's just not having been the right time or the right connection and so I'm just trying to learn about my body".* This represents how, although P2 are not sure about the reason they have not yet become pregnant, P2A feels she is still taking responsibility through gaining body literacy. P2A later described how she felt that P2B was collaborating in the attempt to become pregnant by eating healthily and keeping up an active lifestyle rather than participating in the act of fertility tracking itself.

P4B's comments reflect his understanding of fertility tracking as a private act, and that it would be a violation of this privacy for the partner doing the testing to share the information with the partner. When asked about his role in their previous experience of urine tracking, he said; *"She showed me once, but we still have a few personal things (laugh), which is to say that she doesn't show me everything"* (P4B). Our conversation with P4 about their roles in their fertility tracking practices led to P4A voicing a sense of responsibility for not involving P4B; *"I don't know if I think you'd be super interested. I think you want to know if I'm ovulating… So maybe I'm not very good at including him, more than you not being a part of it"* **(**P4A).

D.I.Y.

The Do It Yourself (D.I.Y.) aspect of the method of saliva tracking was the reason that we initially chose the method for our design. In contrast to other methods, there is no diagnostic process in the testing procedure, only magnification; users are forced to use their own judgement in reading what the information means.

Initial Optimism

Initial reactions from participants after receiving the device were that is was *"easy"* (P1A, P2A, P6A), *"clear"* (P2A, P6A), and *"user friendly"* (P4A). These opinions refer both to interactions with the device and with the method of saliva tracking. It quickly became evident to us that we could not easily separate these two aspects of the device. Since saliva tracking is not a well-known or experienced method of fertility tracking, reactions to it were strong and in fact were the major topic of our interviews.

P1A, P2A and P4A described the benefit of being able to test when in any physiological state and at any time. This is with the restriction of not using the device until two hours after eating or brushing teeth. These statements related to the fact that they had all previously used basal body temperature tracking, which must be done as soon as the user wakes to reach the lowest body temperature possible, and temperature tracking cannot be used when the user is sick, hungover, or has slept for less than 6 hours since these factors affect the temperature of the body. P2A also pointed out how urine tracking also restricts the user from urinating up to four hours before testing in order to strengthen the urine sample.

Initial reactions also reflected the fact that the saliva tracking method reflects hormonal changes in real time; "*The crystals build up, it's giving you more information than the LH surge which is maybe a shorter timeframe and you maybe you miss your ovulation so in that way it's good and easier to use also."* (P2A). This is in contrast to basal body temperature tracking which only shows when the egg has been released, and urine tracking, which only shows the hormone surge 24-36 hours before the egg is released. Saliva tracking provides a longer depiction of the fertile window.

Erratic Results

Initial perceptions of the device changed over the three-month study. This was due to the fact that the method of salivatory tracking proved to give inconsistent results for all participants at one time or another. All but one participant (P1) that completed the full three-month study did experience Ovum to function as expected for at least one menstrual cycle. P7 also appeared to achieve the predicted results, but since they became pregnant during that first cycle, we cannot know if the subsequent cycles would have

followed this pattern. However, during the times when the results were not as expected, what seemed to be a scientifically proven and valid method of tracking fertility proved to be far more ambiguous and erratic than we had expected from reading the scientific studies outlined earlier in this paper.

The pamphlet that accompanied the device gave images as to what the expected projections would be over the menstrual cycle (Figure 5.). This was the only visual guide provided to offer guidance on what to look for in the projection. Most participants voiced insecurity about reading their own samples since they did not align with the images provided in the pamphlet; "*You know it's like you stare at it so much so you don't really know in the end what you're looking at. So, in that way this is harder because it's not very clear yes or no. It's like depending on what you see and since I haven't seen it like in the example, I don't know where I'm at."* (P6A). Since participants' projections did not match up to this illustration, this pamphlet was critiqued for providing a too-narrow range of possible results; "*it will be good with some note (in the pamphlet) ... Like it can be different. It can vary from woman to woman and also that it can look in different ways. It's not like these three are: that's it!"* (P6A).

Is it Ovum or My Body That's Wrong?

Ambiguity in the results shown by Ovum were received as signals that it was their own bodies that were producing these erratic results. *"I'm just wondering does the saliva tests indicate something like if I have a hormonal problem or I don't have enough of let's say progesterone. It's quite interesting to know but it's not worrying me."* (P1A). *"Well I'm thinking if there's any like hormones that I'm deficient in that is not producing that type of crystals in the saliva?"* (P2A), *"like is there something wrong with my saliva. Am I not producing enough of whatever it is I'm supposed to produce?"* (P6A). These reactions show that fertility tracking devices can become diagnostic tools when bodies do not behave in line with the expectations of the device.

Clinical Trial or Design Deployment

Saliva tracking was a novel method for all participants, who had no knowledge of what existing saliva tracking devices looked like or how they functioned. This meant that our participants did not separate issues around the method of saliva tracking from the design of the device. P2 and P4 explicitly referred to the study as a "clinical trial". This was despite our participants having been informed at the beginning of the study, and throughout, that they were not participating in a clinical trial of the method of saliva tracking, but rather an interaction design study on the device.

Experimental Practices

The lack of expected results altered our participant's perceptions of Ovum over the course of the study. To mitigate this sensation of unease, a number of experimental practices arose.

P6 began running their own experiments by testing twice every morning, with a half-hour break in between, without brushing teeth or eating. This gave different results and typically the second procedure gave the results expected. This inconsistency in results led to a judgement of the device being time consuming since it took double the time and was deemed untrustworthy since getting two different results undermined the replicability of the results. P4 also experimented with testing in the early evening after returning from work instead of the morning as recommended in the pamphlet.

To negotiate the ambiguous results of the projected saliva sample, P7, P4 and P1 emailed photos of their projections with questions for us about whether there were crystals visible. For example; *"I want to hear your opinion. Is it ovulation time now?"* (P7A email), *"I sent pictures to you… they look kind of different because they can be pointy or they can be bendy"* (P4A email).

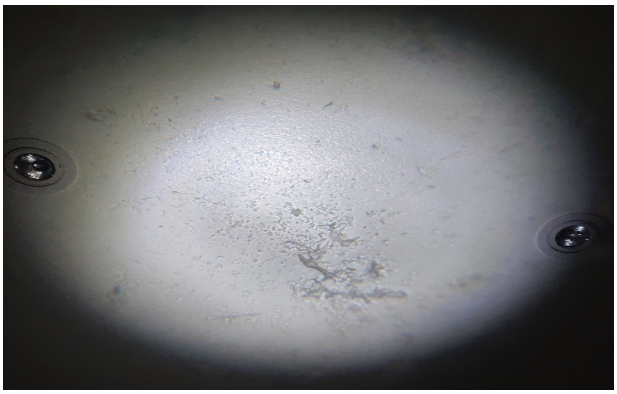

Figure 6. Image of P1's projection sent via email.

At some point or other, all participants integrated other methods into their fertility tracking practices alongside Ovum. This included basal body temperature tracking, urine testing, and cervical mucus tracking. Integrating other methods ranged from continuing previously used methods, to re-introducing old methods to compare the results offered by Ovum. Motivations for continuing or re-introducing these other methods included the goal to corroborate what was shown by Ovum: *"I'm just trying to find like signs of it. I'm trying to find a pattern."* (P2A); to make up for a mistrust of Ovum: *"I wouldn't trust just this device but I would, I think it's fun to use it with other like body temperature and other stuff. I wouldn't trust just this one"* (P6A); and as seeing changes in cervical mucus was unavoidably evident for P4A when going to the toilet since she had learnt how her cervical mucus changed over the menstrual cycle. Visiting the gynecologist also changed how Ovum was understood by our participants. P2's reading from Ovum was evaluated as "correct" by the gynecologist who agreed that ovulation was just about to take place, and P4's as "incorrect", she had another 5-6 days to go before ovulation, in spite of her reading of Ovum that had told her she was just about to ovulate.

Ambiguity and Fertility Tracking

In addition to supporting the fact that ambiguity appears to be a common aspect of fertility tracking, we also found that our participants attitudes towards their bodies pointed to the fact that ambiguity is an integral aspect of self-tracking more generally. Despite the ambiguous, and occasionally erratic, nature of results shown by Ovum, out of the 4 participants who completed the full 3-month long deployment, 3 of the participants asked of their own accord to continue to use the device after the study was over. P1, P4 and P6 continued after the study had ended. P1 returned their device after two months saying they *"weren't seeing anything new"*. P4 and P6 currently still have theirs at the time of writing in August, 2019. Emails to P4 and P6 asking for updates on using the device in the long term were unanswered. When asked about their motivation for wanting to keep the device, all three said that they suspected their cycles had been abnormal for a range of reasons over the last three cycles. Since results can also vary over menstrual cycles due to the changeable nature of the body, our participants wanted a longer deployment for the sake of their own experimentation. This illustrates that users of fertility tracking devices do not judge the device's efficacy based on a binary notion of the device "working" or "not working" with one short period of use; different menstrual cycles could provide different results.

DISCUSSION

Our research answers calls for designers to consider how the design of self-tracking devices influence users' experience of themselves and their bodies [30, 41, 45]. These calls state that designers should think beyond the efficacy and accuracy of the self-tracking devices that they produce. Our research explored the implications of expanding the design space of self-tracking through challenging the experiences facilitated by existing self-tracking devices. Above we presented our findings that relate to how the experiential qualities we worked with in the design process translated into actual use and other findings that arose during the deployment. Our discussion reflects on these findings. We also contribute a discussion of how designing for the body places interaction designers in novel and complex roles and situations.

From Sculptural to Clumsy

We situated the act of fertility tracking in the home through the form and materiality of our design. Rather than producing a device that replicated a clinical experience of self-tracking, we aimed for domestic and homeware aesthetics through using ceramic materials and a rounded form. Our findings showed that our participants' experience of the design of Ovum changed over time. Ovum's aesthetic qualities were initially appreciated and seen as desirable aspects of the device. However, over the three-month deployment, more practical aspects became more important; such as the fact that it was challenging to transport the device because of its form. Rather than continuing to appreciate the experience provided by Ovum, our participants appeared to move towards a desire for a practical tool to provide information on their fertile state.

Our findings contribute knowledge about the limits of design in reconfiguring what self-trackers desire from their devices. Although we have shown how designers can offer different types of experiences of self-tracking through their design work, we found that users inevitably desire devices that provide information rather than experiences. If designers are to design for more than effective and accurate self-tracking devices, then this phenomenon must be considered. Our findings show the importance of long-term deployments of fertility tracking devices to surface issues that only arise once the aesthetic qualities of self-tracking devices have worn off.

Limitations in Sharing Fertility Tracking

In aiming for more than efficacy and accuracy through designing for different experiences than those offered by existing self-tracking devices, we also situated self-tracking within a social context. We aimed to make fertility tracking a shared, rather than individual, act through projecting the saliva sample out into the room. Though we did not directly instruct our participants to use Ovum together, the roles that they played in their fertility tracking practices were discussed in our interviews.

There was evidence that aspects of the design of Ovum led to a shared experience, e.g. where our participants wanted to share the "beautiful" experience of seeing crystals in the projection with their partners. However, overall, the female partner was still the primary user of the device. Our findings show how many factors influence social aspects around self-tracking. This includes how self-tracking practices are shaped by daily routines, such as the fact that conflicting schedules were a key reason for both partners not being involved in the tracking over time. The fact that is it one body that is the key site of fertility tracking was also a factor mitigating shared fertility tracking practices; it did not occur to our participants that this should be a shared experience because only one person's saliva was required. P4's reflection that she was responsible for not involving her partner in her tracking practice and P1's irritation at the inequality in gender roles in fertility tracking reflect that participating in the study itself altered opinions on roles within fertility tracking. To summarize, although designers have the agency to reconfigure social practices of self-tracking through proposing alternative experiences, designing for self-tracking as a social act requires the negotiation of existing societal norms and assumptions.

Supporting and Undermining the User as Expert

Saliva tracking became the method we chose to design with because of the fact that it allowed for a DIY, rather than expert-led, reading of the body. Over time, we imagined users of Ovum becoming experts in reading their own bodies as they gained a familiarity with their own patterns of ferning crystallization. We imagined that they would co-construct their knowledge of their own fertility with the Ovum device. In fact, we did see our participants using self-experimentation to become experts in reading their own fertile states. This supports research that states that

researchers deploying technologies designed for the body must expect and be prepared for participants to tinker with the devices in order to make ambiguous results make sense for them [24]. P6 and P4 both tinkered with their devices by testing more than once a day and at a different time of day.

Methods that support users in co-constructing knowledge with technological devices have used ambiguity in order to harness user's own abilities to make meaning from data. This has been shown to foster engagements and allow users to appropriate technologies into their own lives [16, 23]. *Interactional empowerment* is an approach to affective computing that uses ambiguity in order to construct understandings of emotions [50]. The difference between tracking emotions and tracking physiological processes, such as menstrual cycles, is the fact that it is possible to use clinical procedures to ascertain whether physiological processes are taking place. We saw how our participants used several different tracking methods at the same time in order to make sense of and validate their data. To use Anne-Marie Mol's terminology; multiple bodies (or realities of the body) are being produced through the various methods of fertility tracking [36]. In the case of Ovum, whether or not Ovum correctly revealed that the user was fertile and approaching ovulation could be confirmed or contradicted with an internal inspection. This would allow a clinician to physically see the egg ready to be released out of the ovary.

It is possible that, since our participants were not able to do internal inspections on themselves, they felt that they were not qualified as experts in knowing their own fertility. The ambiguity of reading the saliva sample became an "insecure" (P4) and "confusing" (P3) process, which they knew could be undermined by a trip to the gynecologist. P7 and P4 negotiated the ambiguity of the results of using Ovum by emailing us asking us to read the results of their saliva sample for them. Here they expected that we could read their results more accurately than they could. In contradiction to our desire to design Ovum to facilitate a DIY, rather than expert-led, experience; ambiguity led to us researchers being placed in the expert role, rather than our participants. Overall, although we aimed for our participants to *feel* like experts in reading their own bodies through using the method of saliva tracking, the ambiguous nature of the method itself appeared to result in the opposite effect.

Designers in White Coats

The ambiguous aspects of the method of saliva tracking outlined above had consequences for our own experience as researchers. In particular, the fact that our participants turned to us as experts in the method of saliva tracking, thereby seeing us as designers in white coats. We contribute aspects of our experience of deploying Ovum that might be encountered by designers adopting scientific and medical knowledge about the body in their design work.

There has been a call for researchers within the HCI and interaction design community to include their own emotional experience within their publications [6, 20, 29, 38, 55]. Accounting of the emotional experience of doing research can contribute to a fuller documentation of the research process, and can enable researchers to learn how emotion is used and what it produces within the research process [6]. Within the scope of this research, accounting for our own emotional experience allows us to point to key issues of designing and deploying devices that replicate medical and clinical apparatus, without the training of medical researchers. Our experience is drawn from the fact that we were designing for the body. These experiences resulted from the multiple complexities around deploying a self-tracking device within the emotional, complex and serious domain of fertility tracking [12]. If we were designing a tracking device attending to another facet of life, for example air quality, we would not have been placed in the same role.

Our experience represents the relationship between design research and medical science. Since we are not experts in biology, we relied on scientific research to ground our designs. Ovum was built on our confidence in the method of saliva tracking. This trust came from reading the multiple clinical trials of the method. Although we knew that the method had been reported as inconsistent [7, 43], the accuracy rates of 86.5% [44] to 90% [15] and the fact that FDA approved saliva tracking devices existed [42], convinced us that it was a valid enough method to design with. Our study did not show the method of saliva tracking to be invalid, nor was that the goal of the study. However, since, on occasion, the results of saliva tracking were not as expected, this required mitigation and management on our part as interaction designers. Though it is possible that our participants did have menstrual cycles and hormonal compositions that were incompatible with the method of saliva tracking, determining this was not the aim of our study. Since we, as interaction design researchers, do not have a medical or scientific training, we were unqualified to answer questions and concerns raised by participants about whether their erratic results were related to underlying health or fertility issues. We declined to answer questions beyond what we knew about what the saliva tracking method itself was measuring. When asked questions about what the erratic results might mean for their fertility, we repeated the fact that we were not medical experts and therefore could not answer their questions.

To hear our participants openly worry that the results of saliva tracking might be a diagnosis for something being "wrong" with their bodies felt uncomfortable. [48] discovered the same tendency of participants to take ambiguous results around fertility as signs of ill menstrual cycle health. This highlights the fact that every time we design an artefact we make a definition [46]. Through designing Ovum and its accompanying pamphlet, we defined what a normal result of saliva tracking should look like. When our participants felt that they did not fit the "normal" definition, then this re-enforced diagnoses of abnormality and ill health.

As well as presenting the implications of designing for fertility tracking as a shared, domestic and DIY experience, a key contribution from our research is offering a situated study of the actual user experience of the method of saliva tracking. The user experience of saliva tracking was as an ambiguous and erratic method, and this had an impact on our study as a whole. In line with our participant's criticisms of the pamphlet accompanying Ovum, one way to avoid this might be by providing more clarity about the ambiguity of results of saliva tracking methods throughout the whole study, and not only in the initial stages when recruiting participants. By providing a less reductive and normate depiction of results for participants to compare themselves against in the pamphlet, we might have avoided Ovum becoming a diagnostic device. However, since saliva tracking appeared to be an accepted and scientifically validated method from our prior research, and it was only in our long-term, situated, study that these aspects arose, we were not aware of the ambiguous and erratic nature of saliva tracking when carrying out our design work. Rather than simply being a re-design of an accepted self-tracking device, our experience highlights the consequences of implementing scientific validated knowledge in design work, and how long-term deployments can reveal particular aspects of scientific methods in practice.

We discussed how, if we were running a clinical trial rather than a design deployment, then we would have been less emotionally involved in the process. Medical trails of saliva tracking use comparisons with other clinical methods to confirm whether or not the method can be used to predict and track ovulation. This is a stark contrast to our methods where we drew our findings from the self-reported experience of the users. Arguably, researchers in the field of medicine who run clinical trials are trained to separate the flesh of the body from the person who is living through that body [32, 52]. Interaction design research uses qualitative methods to attempt to understand the lived experience of technologies with the goal of gaining a rich understanding of the emotional and idiosyncratic experience of the user. Our backgrounds as interaction design researchers have led to us developing a heightened ability to listen out for and empathize with our participant's emotional experiences. This meant greater emotional engagement on our part. We were designing for the user as not only a body, but also a person with emotions, relationships and a specific context.

P2 and P4 both referred to the deployment of Ovum as a clinical trial; they could not divorce the information being provided through the method of saliva tracking from the design of the device itself. We do not suggest that designers can train participants to distinguish what is a reflection on the design aspects, and what is a reflection on the self-tracking method. One way to avoid the uncomfortable aspects of being a designer perceived as a healthcare professional might be to employ healthcare professionals to refer participant's queries and concerns to, rather than referring to the information given in scientific papers. However, this would not remove the task of the designer in taking the self-tracking method into account as an integral aspect of the study. When studying the user experience of self-tracking devices, we can see no way of divorcing the method of reading the body from the device it is enacted through. Rather, this paper highlights to designers taking on this type of research how married these two aspects are.

CONCLUSION

To the increasing body of work on the research through design of self-tracking and fertility tracking devices, we contribute a study on the deployment of Ovum. Ovum is a saliva tracking device designed for fertility tracking as a DIY, shared, domestic experience, rather than an expert-led, individual, clinical experience. Ovum was designed in order to investigate how designing with oppositional experiential qualities impacted the experience of self-tracking. This paper unpacked the findings from a three-month long deployment of Ovum with seven couples trying to conceive. Findings included the way that the experiential qualities aimed for in the design process translated into the lived experience of the participants. For example: that the aim of creating a shared experience of fertility tracking facilitated conversations around the labour of fertility tracking; that the domestic design of Ovum was first appreciated for its aesthetics, and later criticized for its impracticalities; and that the fact that our participants had to create their own meaning from their data produced feelings of insecurity that led them to turn to us as "experts". The contrast between the guidelines given to our participants in the pamphlet we designed to accompany Ovum and the more erratic and ambiguous results of their own devices provoked our participants to tinker with the testing process to achieve more accurate results, to turn to us as experts, and to triangulate results with other fertility tracking methods. We also contribute findings related to the fact that the ambiguous and erratic nature of the body changing over menstrual cycles influences user's judgements of fertility tracking devices that goes beyond a binary question of whether it "works", or "doesn't work".

We conclude with a contribution of an account of our own experience as researchers in order to develop understandings of how designing for the body places interaction designers in novel and complex situations. This research has shown how when we design for the body, we encounter issues and topics not present in other design spaces. In the case of this study, designing a fertility tracking device based upon an accepted method of saliva tracking resulted in the negotiation of emotional and complex topics when the method produced ambiguous and erratic results. In other situations, when digital devices do not provide expected results, their validity is doubted. In the case of tracking bodies, unexpected results translated into diagnoses of abnormality and ill-health. As interaction designers, negotiating these aspects was emotionally taxing. We discuss how this is due to our training in honing our skills in understanding our participant's emotional experience of technological devices.

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